Why the Parity Violation

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Abstract

The sufficient and necessary conditions for a nonzero fermion mass without Higgs are considered. The Parity Violation is deduced from these conditions.

In this paper I consider a global gauge transformation.
I use the following notation:

$$1_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, 0_2 = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}, p_u = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, p_d = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$$

$$\sigma_x = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}, \sigma_y = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}, \sigma_z = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix},$$

$$\beta_1 = \begin{bmatrix} \sigma_x & 0_2 \\ 0_2 & -\sigma_x \end{bmatrix}, \beta_2 = \begin{bmatrix} \sigma_y & 0_2 \\ 0_2 & -\sigma_y \end{bmatrix}, \beta_3 = \begin{bmatrix} \sigma_z & 0_2 \\ 0_2 & -\sigma_z \end{bmatrix},$$

$$\beta_4 = i \cdot \begin{bmatrix} 0_2 & 1_2 \\ -1_2 & 0_2 \end{bmatrix}, \beta_0 = \begin{bmatrix} 1_2 & 0_2 \\ 0_2 & 1_2 \end{bmatrix} = 1_4, \gamma_0 = \begin{bmatrix} 0_2 & 1_2 \\ 1_2 & 0_2 \end{bmatrix},$$

$$\gamma_5 = \begin{bmatrix} 1_2 & 0_2 \\ 0_2 & -1_2 \end{bmatrix},$$

$$1_8 = \begin{bmatrix} \beta_0 & 0_4 \\ 0_4 & \beta_0 \end{bmatrix},$$

$$0_8 = 1_8 - 1_8,$$

$$\gamma_1 = \gamma_0 \cdot \beta_1,\ \gamma_2 = \gamma_0 \cdot \beta_2,\ \gamma_3 = \gamma_0 \cdot \beta_3,\ \gamma_5 = i \cdot \gamma_0 \cdot \beta_4,$$

$$0_4 = \begin{bmatrix} 0_2 & 0_2 \\ 0_2 & 0_2 \end{bmatrix}, \underline{\gamma_0} = \begin{bmatrix} \gamma_0 & 0_4 \\ 0_4 & \gamma_0 \end{bmatrix}, \underline{\beta_n} = \begin{bmatrix} \beta_n & 0_4 \\ 0_4 & \beta_n \end{bmatrix}.$$

1 Hints

1) Let us consider the free lepton Lagrangian [1]:

$$\mathcal{L} = 0.5 \cdot i \cdot \left(\overline{\psi} \cdot \gamma^\mu \cdot (\partial_\mu \psi) - \left(\partial_\mu \overline{\psi}\right) \cdot \gamma^\mu \cdot \psi\right) - m \cdot \overline{\psi} \cdot \psi.$$

Hence:

$$\mathcal{L} = 0.5 \cdot i \cdot \left(\psi^\dagger \cdot \beta^\mu \cdot (\partial_\mu \psi) - \left(\partial_\mu \psi^\dagger\right) \cdot \beta^\mu \cdot \psi\right) - m \cdot \psi^\dagger \cdot \gamma^0 \cdot \psi.$$

This Lagrangian contains four matrices from the Clifford pentad [2]

$$\{\gamma_0,\ \beta_1,\ \beta_2,\ \beta_3,\ \beta_4\},$$

but one does not contain β_4.
2) Let us consider the lepton current:

$$j_\mu = \psi^\dagger \cdot \beta^\mu \cdot \psi.$$

for $0 \leq \mu \leq 3$.
Let us denote:

$$J_\gamma = \psi^\dagger \cdot \gamma^0 \cdot \psi \text{ and } J_4 = \psi^\dagger \cdot \beta^4 \cdot \psi.$$

In this case if

$$\rho = j_0$$

then the average velocity vector is:

$$\rho \cdot v_x = j_1,\ \rho \cdot v_y = j_2,\ \rho \cdot v_z = j_3.$$

Let us denote:

$$\rho \cdot V_\gamma = J_\gamma \text{ and } \rho \cdot V_4 = J_4.$$

In this case:

$$v_x^2 + v_y^2 + v_z^2 + V_\gamma^2 + V_4^2 = 1.$$

Hence of only all five elements of the Clifford pentad lends the entire kit of the velocity components.

3) In the Standard Model we have got the following entities:
the right electron field vector e_R,
the left electron field vector e_L,
the electron field vector e ($e = \begin{bmatrix} e_L \\ e_R \end{bmatrix}$),
the left neutrino fields vector ν_L.
the zero right neutrino fields vector ν_R.
the unitary 2×2 $SU(2)$ matrix U of the isospin transformation:

$$U = \begin{bmatrix} \cos(\varepsilon) + i \cdot n_3 \cdot \sin(\varepsilon) & (i \cdot n_1 + n_2) \cdot \sin(\varepsilon) \\ (i \cdot n_1 - n_2) \cdot \sin(\varepsilon) & \cos(\varepsilon) - i \cdot n_3 \cdot \sin(\varepsilon) \end{bmatrix},$$

ε, n_1, n_2, n_3 are real and:

$$n_1^2 + n_2^2 + n_3^2 = 1.$$

This matrix acts on the vectors of the kind: $\begin{bmatrix} \nu_L \\ e_L \end{bmatrix}$.

Therefore, in this theory (the (j,0)+(j,0) representation space: [3], [4], [5]): if

$$U = \begin{bmatrix} u_{1,1} & u_{1,2} \\ u_{2,1} & u_{2,2} \end{bmatrix}$$

then the matrix

$$\underline{U} = \begin{bmatrix} u_{1,1} \cdot 1_2 & 0_2 & u_{1,2} \cdot 1_2 & 0_2 \\ 0_2 & 1_2 & 0_2 & 0_2 \\ u_{2,1} \cdot 1_2 & 0_2 & u_{2,2} \cdot 1_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 1_2 \end{bmatrix} \tag{1}$$

operates on the vector

$$\begin{bmatrix} \nu_L \\ \nu_R. \\ e_L \\ e_R \end{bmatrix}$$

Because e_R, e_L, ν_L, ν_R are the two-component vectors then

$$\begin{bmatrix} \nu_L \\ \nu_R \\ e_L \\ e_R \end{bmatrix} \text{ is } \begin{bmatrix} \nu_{L1} \\ \nu_{L2} \\ \nu_{R1} \\ \nu_{R1} \\ e_{L1} \\ e_{L2} \\ e_{R1} \\ e_{R1} \end{bmatrix}$$

$\underline{U}$ has got eight orthogonal normalized eigenvectors s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8:

$$s_1 = \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, s_2 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, s_3 = \begin{bmatrix} a \\ 0 \\ 0 \\ 0 \\ b + i \cdot c \\ 0 \\ 0 \\ 0 \end{bmatrix}, s_4 = \begin{bmatrix} 0 \\ a \\ 0 \\ 0 \\ 0 \\ b + i \cdot c \\ 0 \\ 0 \end{bmatrix},$$

$$s_5 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}, s_6 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}, s_7 = \begin{bmatrix} -b+i\cdot c \\ 0 \\ 0 \\ 0 \\ a \\ 0 \\ 0 \\ 0 \end{bmatrix}, s_8 = \begin{bmatrix} 0 \\ -b+i\cdot c \\ 0 \\ 0 \\ 0 \\ a \\ 0 \\ 0 \end{bmatrix}$$

(a, b, c are a real numbers) with the corresponding eigenvalues: 1, 1, $\exp(i\cdot\lambda)$, $\exp(i\cdot\lambda)$, 1, 1, $\exp(-i\cdot\lambda)$, $\exp(-i\cdot\lambda)$.

Let: K be the 8×8 complex matrix, constructed by s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8 as the following:

$$K = \begin{bmatrix} s_1 & s_2 & s_3 & s_4 & s_5 & s_6 & s_7 & s_8 \end{bmatrix}.$$

Let for all k ($1 \leq k \leq 8$):

$$h_k = \underline{\gamma_0}\cdot s_k$$

and let:

$$M = \begin{bmatrix} h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 & h_8 \end{bmatrix}.$$

Let:

$$P_3 = \begin{bmatrix} 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & p_u & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \end{bmatrix}, P_4 = \begin{bmatrix} 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & p_d & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \end{bmatrix},$$

$$P_7 = \begin{bmatrix} 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & p_u \end{bmatrix}, P_8 = \begin{bmatrix} 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & 0_2 \\ 0_2 & 0_2 & 0_2 & p_d \end{bmatrix}.$$

In this case the projection matrices are:

$$
\begin{gathered}
Y_1 = M \cdot P_3 \cdot M^\dagger, \\
Y_2 = M \cdot P_4 \cdot M^\dagger, \\
Y_3 = K \cdot P_3 \cdot K^\dagger, \\
Y_4 = K \cdot P_4 \cdot K^\dagger, \\
Y_5 = M \cdot P_7 \cdot M^\dagger, \\
Y_6 = M \cdot P_8 \cdot M^\dagger, \\
Y_7 = K \cdot P_7 \cdot K^\dagger, \\
Y_8 = K \cdot P_8 \cdot K^\dagger.
\end{gathered}
$$

The vectors:

$$
\underline{e} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ e_{L1} \\ e_{L2} \\ e_{R1} \\ e_{R2} \end{bmatrix}, \underline{e_R} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ e_{R1} \\ e_{R2} \end{bmatrix}, \underline{e_L} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ e_{L1} \\ e_{L2} \\ 0 \\ 0 \end{bmatrix}.
$$

correspond to the vectors e, e_R and e_L resp.
Let:

$$
\begin{gathered}
X_a = Y_1 + Y_2 + Y_3 + Y_4, \\
X_b = Y_5 + Y_6 + Y_7 + Y_8, \\
\underline{e_a} = X_a \cdot \underline{e}, \\
\underline{e_b} = X_b \cdot \underline{e}.
\end{gathered}
$$

In this case:

$$
\begin{gathered}
X_a + X_b = 1_8, \\
X_a \cdot X_b = 0_8, \\
X_a \cdot X_a = X_a, \\
X_b \cdot X_b = X_b, \\
X_a^\dagger = X_a, \\
X_b^\dagger = X_b.
\end{gathered}
$$

Let:

$$\begin{gathered}\rho_a = \underline{e_a}^\dagger \cdot \underline{e_a},\ \rho_b = \underline{e_b}^\dagger \cdot \underline{e_b},\\ J_{\gamma,a} = \underline{e_a}^\dagger \cdot \underline{\gamma_0} \cdot \underline{e_a},\ J_{\gamma,b} = \underline{e_b}^\dagger \cdot \underline{\gamma_0} \cdot \underline{e_b},\\ J_{4,a} = \underline{e_a}^\dagger \cdot \underline{\beta_4} \cdot \underline{e_a},\ J_{4,b} = \underline{e_b}^\dagger \cdot \underline{\beta_4} \cdot \underline{e_b},\\ J_{\gamma,a} = \rho_a \cdot V_{\gamma,a},\ J_{\gamma,b} = \rho_b \cdot V_{\gamma,b},\\ J_{4,a} = \rho_a \cdot V_{4,a},\ J_{4,b} = \rho_b \cdot V_{4,b}.\end{gathered}$$

Let:

$$\begin{gathered}\underline{e_a}' = U \cdot \underline{e_a},\ \underline{e_b}' = U \cdot \underline{e_b}\\ \rho'_a = \underline{e_a}'^\dagger \cdot \underline{e_a}',\ \rho'_b = \underline{e_b}'^\dagger \cdot \underline{e_b}',\\ J'_{\gamma,a} = \underline{e_a}'^\dagger \cdot \underline{\gamma_0} \cdot \underline{e_a}',\ J'_{\gamma,b} = \underline{e_b}'^\dagger \cdot \underline{\gamma_0} \cdot \underline{e_b}',\\ J'_{4,a} = \underline{e_a}'^\dagger \cdot \underline{\beta_4} \cdot \underline{e_a}',\ J'_{4,b} = \underline{e_b}'^\dagger \cdot \underline{\beta_4} \cdot \underline{e_b}',\\ J'_{\gamma,a} = \rho'_a \cdot V'_{\gamma,a},\ J'_{\gamma,b} = \rho'_b \cdot V'_{\gamma,b},\\ J'_{4,a} = \rho'_a \cdot V'_{4,a},\ J'_{4,b} = \rho'_b \cdot V'_{4,b}.\end{gathered}$$

In this case:

$$V_{\gamma,a} = V_{\gamma,b},\ V_{4,a} = V_{4,b}$$

but:

$$\begin{gathered}V'_{\gamma,a} = V_{\gamma,a} \cdot \cos(\lambda) - V_{4,a} \cdot \sin(\lambda),\\ V'_{4,a} = V_{4,a} \cdot \cos(\lambda) + V_{\gamma,a} \cdot \sin(\lambda),\\ V'_{\gamma,b} = V_{\gamma,b} \cdot \cos(\lambda) + V_{4,b} \cdot \sin(\lambda),\\ V'_{4,b} = V_{4,b} \cdot \cos(\lambda) - V_{\gamma,b} \cdot \sin(\lambda).\end{gathered}$$

Hence, every isospin transformation U divides a electron on two components which scatter on the angle $2 \cdot \lambda$ in the space of $(J_\gamma,\ J_4)$.

Hence β^4 must be inserted into Lagrangian.

2 Sufficient Conditions

Let $\underline{\psi}$ be any field of the following type:

$$\underline{\psi} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \psi_{L1} \\ \psi_{L2} \\ \psi_{R1} \\ \psi_{R2} \end{bmatrix}.$$

The value of the form

$$\begin{gathered}\left(\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{a}\cdot\underline{\psi}\right)^{2}+\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{a}\cdot\underline{\psi}\right)^{2}\right)^{0.5}+\\+\left(\left(\underline{\psi}^{\dagger}\cdot\gamma^{0}\cdot X_{b}\cdot\underline{\psi}\right)^{2}+\left(\underline{\psi}^{\dagger}\cdot\beta^{4}\cdot X_{b}\cdot\underline{\psi}\right)^{2}\right)^{0.5}\end{gathered}\tag{2}$$

does not depend from the choice of the $SU(2)$ matrix U and the Lagrangian:

$$\begin{gathered}\mathcal{L}_{\psi}=0.5\cdot i\cdot\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{\mu}\cdot\left(\partial_{\mu}\underline{\psi}\right)-\left(\partial_{\mu}\underline{\psi}\right)^{\dagger}\cdot\underline{\beta}^{\mu}\cdot\underline{\psi}\right)-\\-m_{\psi}\cdot\left(\begin{array}{c}\left(\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{a}\cdot\underline{\psi}\right)^{2}+\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{a}\cdot\underline{\psi}\right)^{2}\right)^{0.5}+\\+\left(\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{b}\cdot\underline{\psi}\right)^{2}+\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{b}\cdot\underline{\psi}\right)^{2}\right)^{0.5}\end{array}\right)\end{gathered}$$

is invariant for this $SU(2)$ transformation.

Let us denote:

$$\begin{aligned}\frac{\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{a}\cdot\underline{\psi}\right)}{\sqrt{\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{a}\cdot\underline{\psi}\right)^{2}+\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{a}\cdot\underline{\psi}\right)^{2}}}&=\cos\left(\alpha_{a}\right),\\\frac{\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{a}\cdot\underline{\psi}\right)}{\sqrt{\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{a}\cdot\underline{\psi}\right)^{2}+\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{a}\cdot\underline{\psi}\right)^{2}}}&=\sin\left(\alpha_{a}\right),\end{aligned}$$

$$\begin{aligned}\frac{\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{b}\cdot\underline{\psi}\right)}{\sqrt{\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{b}\cdot\underline{\psi}\right)^{2}+\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{b}\cdot\underline{\psi}\right)^{2}}}&=\cos\left(\alpha_{b}\right).\\\frac{\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{b}\cdot\underline{\psi}\right)}{\sqrt{\left(\underline{\psi}^{\dagger}\cdot\underline{\gamma}^{0}\cdot X_{b}\cdot\underline{\psi}\right)^{2}+\left(\underline{\psi}^{\dagger}\cdot\underline{\beta}^{4}\cdot X_{b}\cdot\underline{\psi}\right)^{2}}}&=\sin\left(\alpha_{b}\right)\end{aligned}$$

Let:

$$\underline{\gamma}=\left(\cos\left(\alpha_{a}\right)\cdot\underline{\gamma}^{0}+\sin\left(\alpha_{a}\right)\cdot\underline{\beta}^{4}\right)\cdot X_{a}+\left(\cos\left(\alpha_{b}\right)\cdot\underline{\gamma}^{0}+\sin\left(\alpha_{b}\right)\cdot\underline{\beta}^{4}\right)\cdot X_{b}.$$

In this case:

$$\underline{\gamma} \cdot \underline{\gamma} = 1_8$$

and if $1 \leq k \leq 3$ then

$$\underline{\gamma} \cdot \underline{\beta^k} = -\underline{\beta^k} \cdot \underline{\gamma}$$

and the Euler-Lagrange equation for $\mathcal{L}_\psi$ is the following:

$$\left(i \cdot \underline{\beta^\mu} \cdot \partial_\mu - m_\psi \cdot \underline{\gamma}\right) \cdot \underline{\psi} = 0.$$

Since

$$\alpha_a = \alpha_b$$

then

$$\underline{\gamma} = \cos\left(\alpha_a\right) \cdot \underline{\gamma^0} + \sin\left(\alpha_a\right) \cdot \underline{\beta^4}.$$

Let $\underline{\psi}$ be a plane wave electron spinor [1] with a positive energy:

$$\underline{\psi} = \left(a_1 \cdot \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ \frac{p_z}{E+m_e} \\ \frac{p_x+i \cdot p_y}{E+m_e} \end{bmatrix} + a_2 \cdot \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ \frac{p_x-i \cdot p_y}{E+m_e} \\ \frac{-p_z}{E+m_e} \end{bmatrix}\right) \cdot \exp\left(-i \cdot p \cdot x\right),$$

here:
a_1, a_2 are complex, and $E = \sqrt{p^2 + m_e^2}$.
In this case:

$$\cos\left(\alpha_a\right) = 1.$$

Hence

$$\underline{\gamma} = \underline{\gamma^0}$$

and the Euler-Lagrange equation is the following:

$$\left(i \cdot \underline{\gamma^\mu} \cdot \partial_\mu - m_\psi\right) \cdot \underline{\psi} = 0..$$

3 Necessary Conditions

Let $\underline{U}$ be any 8×8 complex matrix for which the Lagrangian

$$\mathcal{L}_0 = 0.5 \cdot i \cdot \left(\underline{\psi}^\dagger \cdot \underline{\beta^\mu} \cdot \left(\partial_\mu \underline{\psi} \right) - \left(\partial_\mu \underline{\psi} \right)^\dagger \cdot \underline{\beta^\mu} \cdot \underline{\psi} \right)$$

is invariant. Hence

$$\underline{U}^\dagger \cdot \underline{U} = 1_8$$

and for all μ $(1 \leq \mu \leq 3)$:

$$\underline{U} \cdot \underline{\beta^\mu} = \underline{\beta^\mu} \cdot \underline{U}.$$

$\underline{U}$ must be of the following type from this commutativity :

$$\underline{U} = \begin{bmatrix} z_{1,1} & 0 & 0 & 0 & z_{1,5} & 0 & 0 & 0 \\ 0 & z_{1,1} & 0 & 0 & 0 & z_{1,5} & 0 & 0 \\ 0 & 0 & z_{3,3} & 0 & 0 & 0 & z_{3,7} & 0 \\ 0 & 0 & 0 & z_{3,3} & 0 & 0 & 0 & z_{3,7} \\ z_{5,1} & 0 & 0 & 0 & z_{5,5} & 0 & 0 & 0 \\ 0 & z_{5,1} & 0 & 0 & 0 & z_{5,5} & 0 & 0 \\ 0 & 0 & z_{7,3} & 0 & 0 & 0 & z_{7,7} & 0 \\ 0 & 0 & 0 & z_{7,3} & 0 & 0 & 0 & z_{7,7} \end{bmatrix}$$

(here $z_{j,k}$ are a complex) and from the unitarity if

$$z_{j,k} = x_{j,k} + i \cdot y_{j,k}$$

then

$$\begin{gathered} 1 - x_{1,5}^2 - y_{1,5}^2 - y_{5,5}^2 \geq 0, \\ x_{1,1} = \sqrt{1 - x_{1,5}^2 - y_{1,5}^2 - y_{5,5}^2}, \\ x_{5,5} = x_{1,1}, \\ x_{5,1} = -x_{1,5}, \\ y_{1,1} = -y_{5,5}, \\ y_{5,1} = y_{1,5} \end{gathered}$$

and

$$1 - x_{3,7}^2 - y_{3,7}^2 - y_{7,7}^2 \geq 0,$$
$$x_{3,3} = \sqrt{1 - x_{3,7}^2 - y_{3,7}^2 - y_{7,7}^2},$$
$$x_{7,7} = x_{3,3},$$
$$x_{7,3} = -x_{3,7},$$
$$y_{3,3} = -y_{7,7},$$
$$y_{7,3} = y_{3,7}.$$

If

$$x_{3,7} = 0,$$
$$y_{3,7} = 0,$$
$$y_{7,7} = 0$$

then

$$z_{3,3} = 1$$

and $\underline{U}$ is the matrix of type (1). In this case the mass form (2) is invariant for $\underline{U}$ and a right-handed particles do not interact by this transformation.

Therefore if an electron has got a nonzero mass, provided with the mass form (2), then all neutrinos must be left-handed.

Like this, for $z_{1,1} = 1$, all antineutrinos must be right-handed to an positron has got a nonzero mass.

If $z_{1,1} \neq 1$ and $z_{3,3} \neq 1$ then a mass form, invariant for $\underline{U}$, does not exist.

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